Paper No. 8

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/255,856	02/23/99	IWASAKI T	501.39631X00

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EXAMINER	
SMOOT, S	
ART UNIT	**PAPER NUMBER**
2813	8

DATE MAILED: 07/10/00

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trad marks

Office Action Summary	Application No.	Applicant(s)	
	09/255,856	IWASAKI ET AL.	
	Examiner	Art Unit	
	Stephen W. Smoot	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-8 is/are pending in the application.

4a) Of the above claim(s) 8 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-7 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

a)☒ All b)☐ Some * c)☐ None of the CERTIFIED copies of the priority documents have been:

1.☒ received.

2.☐ received in Application No. (Series Code / Serial Number) _____ .

3.☐ received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. & 119(e).

Attachment(s)

15) ☒ Notice of References Cited (PTO-892)
16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3 .
18) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
19) ☐ Notice of Informal Patent Application (PTO-152)
20) ☐ Other: .

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of claims 1-7 in Paper No. 6 is acknowledged. The traversal is on the ground(s) that device claims include "product-by-process" limitations and are therefore inherently tied to the method claims that also cite these "product-by-process" limitations. This is not found persuasive in semiconductor manufacturing because "product-by-process" limitations in a "device" claim do not carry significant patentable weight. See MPEP Section 2113.

With respect to applicant's opinion that a search of both method and device claims are not burdensome, examiner notes that separate classes have been established for Semiconductor Device Manufacturing: Process (Class 438) claims and Active Solid-State Devices (Class 257) claims. The examiner notes that a more extensive search of Class 257 is required to address only the patentably significant limitations of the elected device claims.

The requirement is still deemed proper and is therefore made FINAL.

2. Claim 8 is withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in Paper No. 6.

Priority

3. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Specification

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: Semiconductor Device with Layered Interconnect Structure.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

6. Claim 7 is rejected under 35 U.S.C. 102(e) as being anticipated by Woo et al. In claim 7, a semiconductor device is claimed comprising a platinum electrode film formed

on one surface of a semiconductor substrate. A neighboring film, having at least one layer from the group consisting of rhodium (Rh), ruthenium (Ru), iridium (Ir), and osmium (Os), is formed in contact with the platinum electrode. Woo et al. disclose a platinum film (see column 5, lines 4-9) that can be formed on a semiconductor substrate (see column 4, 19-23) with an intermediate layer that can include Ru, Ir, Os, or Rh (see column 4, lines 48-51). They also disclose that a platinum film is usually used as a bottom electrode in a capacitor of a high density DRAM cell or of a non-volatile ferroelectric memory device (see column 1, lines 33-35).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hussein et al. in view of the IBM Technical Disclosure Bulletin.

Referring to Fig. 3, Hussein et al. disclose the following limitations set forth in claims 1-3: a semiconductor substrate (1), a diffusion barrier (5), and interconnect layers (7, 32) that can be copper (see column 3, lines 50-53). However, Hussein et al. do not disclose ruthenium as a diffusion barrier material. The IBM Technical Disclosure

Bulletin does teach that ruthenium (as well as rhenium, osmium, and iridium) is an exceptional barrier against the diffusion of copper (see first sentence of final paragraph). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of the IBM Technical Disclosure Bulletin with those of Hussein et al. and use ruthenium as a diffusion barrier material. Hussein et al. recognize that copper diffusion into silicon and, also into any surrounding dielectric material, can result in defective circuitry (see column 1, lines 55-57).

9. Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand et al. in view of the IBM Technical Disclosure Bulletin.

Referring to Fig. 20, Schacham-Diamand et al. disclose a structure with the following limitations of claims 4-5: a semiconductor substrate (54), copper interconnections (52), and plugs or vias (51). They also disclose the use of a diffusion barrier in contact with the copper interconnect (see column 3, lines 31-33) which is a limitation of claim 5.

However, Schacham-Diamand et al. do not disclose the limitation of claim 4 wherein at least one layer of the plug is selected from the group consisting of rhodium, ruthenium, iridium, osmium, and platinum. They also do not disclose the use of ruthenium as the material for forming the diffusion barrier and the plug (both limitations of claim 5).

The IBM Technical Disclosure Bulletin does teach that ruthenium (as well as rhenium, osmium, and iridium) is an exceptional barrier against the diffusion of copper (see first sentence of final paragraph).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of the IBM Technical Disclosure Bulletin with those of Schacham-Diamand et al. and form a plug per claim 4 having at least one layer of ruthenium, iridium, or osmium in order to prohibit the diffusion of copper into the plug. It also would have been obvious to one of ordinary skill in the art at the time the invention was made to combine these teachings and use ruthenium as both the plug material and the diffusion barrier material per claim 5.

Schacham-Diamand et al. recognize that, in addition to the copper-dielectric interface, the use of diffusion barrier material to encapsulate copper is also necessary at the interfaces of copper with other metals (see column 2, lines 18-21). The interface of the copper interconnect and plug of claims 4-5 is an example of such an interface. In light of the IBM Technical Disclosure Bulletin, see page 215, a person of ordinary skill in the art would have been motivated to use ruthenium, iridium, or osmium metals due to their exceptional resistance against the diffusion of copper.

10. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand et al. and the IBM Technical Disclosure Bulletin as applied to claim 5 above, and further in view of Woo et al.

Although written in independent form, claim 6 has all of the limitations of claim 5 plus a second diffusion barrier, formed of titanium nitride, in contact with the ruthenium diffusion barrier and the ruthenium plug. So, Schacham-Diamand et al. and the IBM Technical Disclosure Bulletin disclose all of the limitations of claim 6 except for the use of a second diffusion barrier. Woo et al. teach that the use of titanium nitride (TiN) layers can perform other functions besides that of diffusion barrier such as improved adhesion between substrate and metal or between metal and dielectric (see column 4, lines 48-51). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the TiN adhesion layer taught by Woo et al. in conjunction with the teachings of Schacham-Diamand et al. and the IBM Technical Disclosure Bulletin in order to obtain improved adherence to the substrate and/or the dielectric.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Manier et al. disclose plugs comprising ruthenium and ruthenium oxide. Zhao et al. disclose encapsulated copper interconnects.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 703-305-0168. The examiner can normally be reached on M-F (8:00am to 4:30pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers can be reached on 703-308-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

sws
July 10, 2000

Charles Bowers
Supervisory Patent Examiner
Technology Center 2800